Software Defined Radio Implementation (With simulation & analysis)

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ABSTRACT
Software Defined Radio is an all new technology being developed in the 21st century. Over a past couple of decades many Mobile communication standards have evolved and even today researches are going to develop new standards. Different standards of Mobile communication use different type of hardware circuitry. The existing mobile communication standards are primarily regional and not global. So efforts are going on to develop systems which can support multiple mobile communication standards using same hardware but swapping the software.

The main aim of this paper is to develop a model of a Software defined Radio using SIMULINK tool to implement the IEEE 802.11 standard and the Bluetooth standard. The main aim of this paper is to build various protocols for WLAN and the Bluetooth standards and to demonstrate their functionality. This includes implementation of IEEE 802.11a standard for the WLAN and basic core protocols for the Bluetooth. According to the IEEE 802.11a standard out of the various transmission modes the basic transmission mode (BPSK with 6Mbps transmission speed) was implemented. For forward error correction half convolution codes are used. The communication channel is assumed to be flat fading channel where the transmitted sub carrier undergoes flat fading. The ideal channel model for this type of channel is chosen as Nakagami channel.

Regarding the Bluetooth technology all the core protocols of Bluetooth are implemented and the type of modulation is Gaussian phase shift keying and frequency hopping spread spectrum.

Objectives and goals of our paper are stated as follows:

- To develop a model of a Software Defined Radio which supports the IEEE 802.11a standard and Bluetooth standard using the SIMULINK tool?
- To implement all the main protocol stacks for WLAN and Bluetooth Protocols and verify their functionality.
- To transmit the data as frames using the format specified for the standard, to compress the binary data using source coding algorithm and also encode the data for Forward Error Correction (FEC).
- To modulate the binary stream of data using the BPSK modulation for WLAN mode which supports the basic transfer mode with 6 Mbps speed.
- For the Bluetooth standard the basic modulation scheme used is GPSK and Frequency hopping spread spectrum is used.
- To implement WEP algorithm for WLAN security and also CRC-16 for protecting the integrity of the data.
- To implement point to point communication and data transfer for the Bluetooth standard.
- To implement CSMA/CA technique and also implement different basic functions such as packet routing, Authentication, Request to transmit etc. for the WLAN standard.
- To develop a suitable channel model to include signal fading and Additive White Gaussian Noise.
- To develop necessary equations for calculation of BER curves for the type of modulation and coding schemes used.

Index Terms
SDR, Simulink, Matlab, Bluetooth

1. INTRODUCTION
Software Defined Radio is a radio communications transceiver system in which all the typical components of a communication system such as mixers, modulators/demodulators, detectors, amplifiers are implemented through software rather than hardware.

This approach is helpful because there is a scope of developing a system which is compatible with more than one mobile communication standard. This can be achieved by using re-configurable hardware and swapping the software for different technologies.

1.1 History of software defined radio evolution.
The initial developments of software defined radio took place during 1970's. During that phase VLF radios which are based on ADC connected to an 8085 microprocessor are used by the ground forces of USA and Great Britain.

The first major push for the development of the SDRs is made through US military paper named SpeakEasy. The primary goal of the SpeakEasy paper was to use programmable processing to emulate more than 10 existing military radios, operating in frequency bands between 2 and 2000MHz. Further, another design goal was to be able to easily incorporate new coding and modulation standards in the future, so that military communications can keep pace with advances in coding and modulation techniques. This paper went on in two phases.

1.2 Speakeasy phase I
From 1992 to 1995, the goal was to produce a radio for the U.S. Army that could operate from 2 MHz to 2 GHz, and operate with ground force radios (frequency-agile VHF, FM, and SINCGARS), Air Force radios (VHF AM), Naval Radios (VHF AM and HF SSB teleprinters) and satellites (microwave QAM). Some particular goals were to provide a new signal format in two weeks from a standing start, and demonstrate a radio into which multiple contractors could plug parts and software.

The paper was demonstrated at TF-XXI Advanced War fighting Exercise, and met all these goals. There was some discontent with certain unspecified features. Its cryptographic processor could not change context fast enough to keep several radio conversations on the air at once. Its software architecture, though practical enough, bore no resemblance to any other.

The basic arrangement of the radio receiver used an antenna feeding an amplifier and down-converter feeding an automatic gain control, which fed an analog to digital converter that was on a computer VME bus with a lot of digital signal processors. The transmitter had digital to analog converters on the PCI bus feeding an up converter (mixer) that led to a power amplifier and antenna. The very wide frequency range was divided into a few sub-bands with different analog radio technologies feeding the same analog to digital converters. This has since become a standard design scheme for wide band software radios.

1.3 SpeakEasy Phase II

The goal was to get a more quickly reconfigurable architecture (i.e. several conversations at once), in open software architecture, with cross channel connectivity (the radio can bridge different radio protocols). The secondary goals were to make it smaller, weigh less and cheaper.

The paper produced a demonstration radio only fifteen months into a three-year research paper. The demonstration was so successful that further development was halted, and the radio went into production with only a 4 MHz to 400 MHz range.

The software architecture identified standard interfaces for different modules of the radio: "radio frequency control" to manage the analog parts of the radio, "modem control" managed resources for modulation and demodulation schemes (FM, AM, SSB, QAM, etc), "waveform processing" modules actually performed the modem functions, "key processing" and "cryptographic processing" managed the cryptographic functions, a "multimedia" module did voice processing, a "human interface" provided local or remote controls, there was a "routing" module for network services, and a "control" module to keep it all straight.

The modules are said to communicate without a central operating system. Instead, they send messages over the PCI computer bus to each other with a layered protocol.

As a military paper, the radio strongly distinguished "red" (unsecured secret data) and "black" (cryptographically-secured data).

Developed primarily for the military applications the Software Defined Radio moved on to civil and commercial applications. A Non-Profit organization called SDR Forum which was previously known as Modular Multifunction Information Transfer System Forum was founded with the aim to develop a set of technical specifications and to define the requirements and eventually standards for the realisation of SDRs. Moving from the initial military background, all branches of the wireless industry ranging from defence, commercial wireless, civil government to regulatory bodies and academia are represented in this forum. The activities of the SDR Forum have helped raising the awareness of this emerging technology and are influencing the regulatory framework for reconfigurable SDR Terminals.

Other research efforts, namely those of the European Commission, provide significant advances in hardware and software technologies, the research frameworks ACTS (Advanced Communications Technologies and Services) and ESPRIT (the EU information technologies programme) initiated papers including FIRST (Flexible Integrated Radio Systems Technology), SORT (Software Radio Technology), and SLATS (Software Libraries for Advanced Terminal Solutions). While the current fifth framework papers include TRUST (Transparently Reconfigurable Ubiquitous Terminal), CAST (Configurable radio with Advanced Software Technology), MOBIVAS (downloadable Mobile Value Added Services through software radio and switching integrated platforms), SODERA (reconfigurable radio for Software Defined Radio for third generation mobile terminals), and PASTORAL (Platform And Software for Terminals Operationally Reconfigurable). Other initiatives include UKs Mobile VCEs Soft-Terminal research with its Reconfiguration Management Architecture as well as many on-going papers in the industry.

Despite such a wide range of activities, and due to the complexity of the problem area there is still a wide area of uncharted territory for fundamental research into re-configurability and the various levels of SDR technology. Successful development of SDR equipments will still require a huge amount of efforts in the next 5–10 years.

1.4 Factors to be considered for installation of WLAN

One of the first considerations facing the enterprise that wants to deploy wireless networking is – which wireless technologies to adopt and when? This part examines the three prevalent standards, 802.11b, 802.11g, and 802.11a and chooses an appropriate standard. We should also look at two wireless LAN (WLAN) architectures – standalone access points and centrally controlled coordinated access points – and choose implementation considerations that can help to decide which type of architectures to adopt in a particular environment.

To help decide which standards-based products to implement a site survey should be performed that identifies the most appropriate wireless technologies and architectures for your environment.

1.5 Site survey

The success of a wireless LAN deployment depends on the site survey, before organizing the WLAN it is necessary to understand the needs of the users in the current environment. The main aim is to identify appropriate technology to apply, obstacles to avoid or eliminate or work around, coverage patterns to adopt and amount of capacity needed. The site survey should yield a network design document that describes the location of each access point, its coverage area, and the 802.11 a, b, or g channel selections for the access point. The network design document should also provide a complete Bill of Materials, indicating the WLAN equipment and supplies, infrastructure equipment and supplies to provide Power over Ethernet (PoE) and additional switch ports.

1.6 User's survey

It describes about the needs, expectations & applications of the user. Also deals with traffic types, volumes and their presence. User's locations and their distance from the access points.

1.7 Work space

It defines the space and usage of WLAN services , also it tells about the work area, room and hallways supported by the wireless infrastructure.

1.8 Obstacles to signal strength

In general, objects absorb or reflect signal strength and degrade or block the signal. Indentifying the obstacles are of utmost importance and those obstacles are walls, furniture, ceiling tiles, natural elements (tree, bush, water), coated glass.

1.9 Security considerations

The inherently open nature of wireless access – compared to the wired world – creates significant security concerns; chief among them is user authentication and rights enforcement, and data encryption. Broadcast signals often travel into public areas that can be accessed by "eavesdropping" individuals who have not passed through any type of authentication process to validate their presence at the site. The site survey should identify the

security status of all the locations considered for wireless access.
The security solution must control network access in different ways for different types of users who may be in the same location. Some users, such as employees, may be entitled to total or broad access. Other users, such as guests or contractors, may be entitled only to more limited access. In a more sophisticated solution, an access controller sits between the access point and the network, functioning as a gatekeeper, or rights administrator, at the network edge. With such a device, for example, employees can be granted access to corporate resources, and guests may be granted only access to the Internet. The site assessment should note where guests, contractors, or other non–employee users may be located, so that appropriate security solutions can be created for those areas.

1.20 Signal noise

Noise from cordless phones, wireless headsets, and other non-protocol devices can interfere with an access point trying to send or receive data. The site survey should identify the sources of signal noise present in each deployment area so that the WLAN can avoid at least the already existing noise sources.

1.21 Stand alone and centrally coordinated wireless networks

In planning a wireless network, one needs to determine which WLAN architectures to adopt in a particular environment. Both architectures standalone access points and centrally coordinated have benefits that are well suited to different environments.
A wireless network, based on standalone access points, relies on the integrated functionality of each access point to enable wireless services, authentication and security.

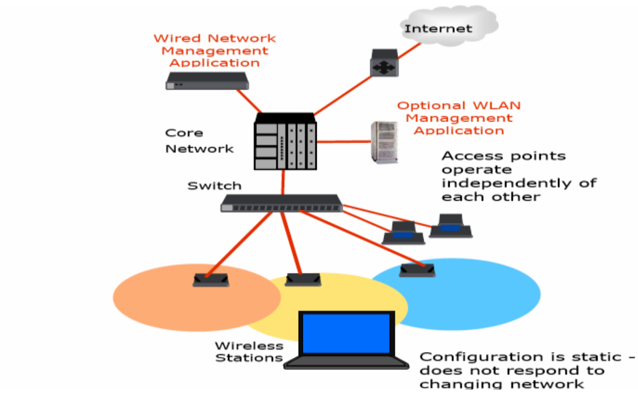

Fig 1 Standalone wireless networks

In a coordinated wireless network, "thin" access points, or radio ports, have much simpler responsibilities most of the heavy lifting is performed by a centralized controller, which handles functions such as roaming, authentication, encryption/decryption, load balancing, RF monitoring, performance monitoring and location services. Because configuration is done once, at the controller, adding additional radios to cover new office areas is as simple as plugging them in.

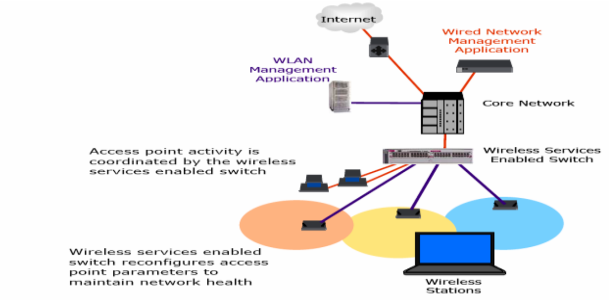

Fig 2 Centrally coordinated wireless networks

2. IMPLIMENTATION CONSIDERATIONS

Both the standalone and centrally coordinated architectures have advantages and disadvantages, depending on the age of the wired infrastructure, deployment area, building architecture, and types of applications that you want to support. Regardless which approach you choose, it is essential that your architecture provide you with a way to manage your network efficiently and effectively.
A standalone access point WLAN is particularly well suited in environments where:

- There is a smaller isolated wireless coverage area that requires only one or a few access points
- There is a need for wireless bridging from a main site building to a branch office or to a remote portable or temporary building such as a portable classroom.

However, the operational overhead to manage and maintain a wireless LAN increases with the size of the wireless LAN deployment. Wireless LAN management tools help simplify configuration and monitoring of the LAN, but the inherent "independence" of these access points presents a challenge in addressing security, configuration control, bandwidth predictability and reliability , As users and applications become dependent on an always available and reliable wireless LAN connection.
A centrally coordinated WLAN is well suited deploy where.

- There are one or more large wireless coverage areas that require multiple radio ports possibly accompanied by several smaller isolated coverage areas.
- RF network self-healing is required.
- A redundant stateful-failover situation is required.

3. METHODOLY FOLLOWED IN SDR

The methodology followed in this paper is chosen in such a way that the paper looks more appropriate and resembles very closely to the software approach followed.
Especially this paper is meant to be entirely simulation; a hardware implementation would be more realistic.

3.1 Issues regarding the implementation of this paper and final implementation

The reasons for not going into hardware implementation for the paper are as follows.

- The hardware implementation for this paper takes longer time, not possible to complete in a few months.
- The hardware required for this paper is highly costly and complex to operate. It demands complex embedded systems and other resources such as computing platforms running on Vx-Works.
- Hardware implementation requires work to be done in various fields and it requires assistance from a large number of professionals.
- Moreover this is an emerging technology and not very commonly available so it would be difficult to obtain

references for the model for its performance evaluation in the real time functionalities.

The implementation is done in SIMULINK because of the following reasons.

- The graphical user interface provided by the Simulink will be better to demonstrate the functioning of different key components such as CPUs and the DSPs.
- With MATLAB and SIMULINK it will be easy to implement various Base Band signal operations.
- The S-function builder blocks can be used to function exactly as we programmed them so the various programming methodologies can be implemented on them.
- The paper closely resembles to the Hardware Implementation.

3.2 Changes in the course of methodology and the final methodology

The initial methodology proposed and the reasons for the deviation from the initial methodology proposed are stated briefly as follows.

- In the initial methodology it was planned to implement a model for Software defined radio which supports WLAN and Personal Handy phone Systems standards was proposed but later the PHS mode was omitted and Bluetooth was included. The reason for this is PHS mode is not very much popular and no proper references are available for it as it is being used by relatively few people in Far East Asia.
- Initially the goal was to obtain the results for the throughput for the system designed, but it became impossible due to problem with the SIMULINK tool. The time for the simulation had to be reduced to half the sampling time to transmit arrays of data in parallel without any duplication of the transmitted data. Using this reduced simulation time throughput of the system can't be verified.
- Finally it was decided to implement various algorithms for FEC, CRC, encoding and decode the raw data bits and verify their functioning bit transmitting the frames over a communication channel.
- The channel was modelled as Nakagami channel as stated in the previous chapter.
- According to the specifications given in the IEEE 802.11 standards Convolutional codes were selected for FEC for WLAN and according to the Bluetooth standards Hamming codes are used as FEC.
- CRC generation algorithm is implemented for both the standards.
- Sample packets are designed are transmitted across to verify the functioning of the designed protocols.
- A limited implementation of WEP algorithm is shown.
- And the most important of it is OFDM technology a single channel or a sub-carrier is transmitted as the model consists of only two transreceivers.
- Only one way communication is fully implemented through all the stages, that is uplink from transmitter to access point is implemented through all the details and signal processing operations. The only reason for this is the memory constraints; SIMULINK cannot assign any given number of the variables at any given time. The down link is connected directly for the transfer of raw data bits.
- The other important reason for inability to calculate the through put of the system is that many of this implementations are done in special Embedded platforms such as a PC running on Vx-Works. Vx-Works supports very small response time than Windows operation systems offer so there will be fall in the performance of the system if it was implemented in Windows. This is the reason why Vx-Works running on a power PC is used as a standard system for 4.5 Generation Fighter Aircrafts like Rafale, F-18 Phalcon, Su-30 MKI etc.
- The final goal of this paper is to demonstrate the functionality of all the software blocks designed, as this includes the transmission of large frames in real time, it is not possible to visualize outputs at different stages completely only a part of the output is tapped separately and plotted

3.3 About the final design model

- All the key components such as CPU and the DSPs are modelled into S-Function Builder blocks.
- The outputs at the various levels of the model are tapped and are displayed for viewing.
- The major results obtained are Different modulation techniques for the generation of the output and the distortion the noise produces on this signals while travelling through the transmission medium, the modelled channel block in this paper.
- SNR of the designed block for various levels of distortion.
- Key algorithms for the above mentioned schemes are written and are included in a main program which controls them and the overall functionality of each block.
- Man Machine Interface is provided through a group of control signals provided to the CPU and CPU controls the DSPs in turn.
- The Pulse shaping, the functionality of the pre/post processors is emitted.
- The noise is not added as a noise block, the signals are imported separately to the workspace and then noise is added in MATLAB.

4. IMPLEMENTATION PROCEDURE

The implementation of the paper should cover various algorithms and the steps followed to generate various signals using different modulation schemes

4.1 Various implementations at various levels

The various implementations which occur at various levels for both the standards are given below.

4.1.1 WLAN

- Firstly CRC is to be calculated for the generated data. CRC-16 and CRC-32 are to be generated as both are used in the WLAN frame.
- Secondly the raw bits generated including the CRC are encoded using source coding technique. The ideal source coding technique is LZ-78 or the Lempel-Ziv coding, but it has some limitations for implementing programming languages like C or even MATLAB compiler itself. The alternative to this is Run length coding, but this may not be very much efficient.
- Then the Forward error correction codes should come into play according to the specifications of IEEE

802.11a standards the FEC used is convolutional codes and are decoded using VERTIBRE algorithm.

- Then next comes modulation scheme, the modulation scheme used for WLAN is simple BPSK modulation.
- Then the next thing is adding noise to the modulated signal, this is done by adding the AWGN through AWGN noise block and fading through importing the signals to workspace, adding the noise in MATLAB and sending them back to the Simulink.
- Then at the receivers end a Gaussian filter is used to filter the AWGN noise, and since the fading is flat and it does not affect the signal much.
- At the receiver the signal is again properly sampled and the timing mismatch is corrected if it is present anywhere.
- This is very important to note that the receiver operations are completely different in a software defined radio. The reason is that all the Baseband Operations are done in software platform rather than different sorts of hardware. It follows that the analogue to digital converter used at the receiver is connected directly to the DSP at the Front End of the receiver. Normally a Pre/post processor should be involved but this is omitted in the model.

4.1.2 Bluetooth

- Relatively easy to implement.
- Frame format for Bluetooth is simple compared to the WLAN protocol and moreover the only thing which is going to be implemented in the Bluetooth is point to point connection and no other complex tasks.
- Bluetooth standard does not state any source coding since the Bluetooth frame is relatively smaller.
- Hamming codes are used for Bluetooth FEC.
- Their channel modelling will be similar to that of WLAN but the SNR will differ and relatively the Bluetooth channel suffers from less attenuation than compared to the normal WLAN channel.
- The key aspect in implementing Bluetooth is authentication. A simple authentication algorithm is used to implement the Bluetooth technology.

4.2 Detailed implementation of above mentioned algorithms

4.2.1 WLAN protocol

4.2.1.1 Source coding

Source coding is implemented using Lempel-Ziv coding. The detailed algorithm is given below.

- Input all the bits coming from the source and store them in an array.
- Increment the values of the bits by one, that is logical one is represented as 2 and zero as 1.
- Start three more arrays one for the code book, other for the index and other for the maximum length of the code word.
- Consider the first bit, add it to the code book and log 1 into the Zero index of the index.
- Input next number. If it is different add it to the code book and increment the index and if it is same add that number and the next number to the last two digits of the third array, and the rest of the array must be zeros. Multiply all the elements of the array with increasing powers of 10 starting from zero in the direction of right to left and add the result to the second array of the code book.
- Repeat this procedure until the code word reaches its maximum length.
- The main drawback of this procedure is that the maximum length of the code word would be the maximum or the greatest integer value and it cannot exceed it.

4.2.1.2 CRC Generation

- Take the bits for which CRC is to be generated and store them in an array.
- Select an appropriate polynomial for 16 bit and 32 bit CRC.
- Define another array of length 15 for 16 bit CRC and 31 for 32 bit CRC; store the polynomial also into another array.
- XOR the first 16 bits of the data and store the remainder in the array just created for them.
- Next add the next bit of the data array to the remainder array as a last element and do the division once again and repeat the above steps.
- Do these till the data is completely divided and the CRC is obtained.

4.2.1.3 Convolutional codes

- According to the state transition diagram developed on paper define a function which has a present state at (0,0) and generates the output states according to the state transition diagram.
- This is a very precise algorithm which works very efficiently and which is easy to implement.
- The decoding is done through Viterbi algorithm.
-

4.2.1.4 BPSK Modulation.

- Buffer all the data to be transmitted into an array.
- Pre define the carrier wave with suitable frequency of the operation.
- Now if the coming input is 1 transmit the same wave and if the input is zero phases shift the wave by simply multiplying it with -1.
- This will give raise to BPSK modulation where one symbol is represented by on wave.

4.2.1.5 *Addition of noise*

- AWGN noise is added by passing the signal through AWGN block.
- The fading is done by importing the signal to workspace and modeling the samples of the input signals by the given Nakagami distribution.

4.2.1.6 Bluetooth

The important algorithms in Bluetooth are CRC, GFSK and the process of authentication.

4.2.2 GFSK Modulation

Algorithm to implement GFSK modulation is given as follows.

- It is similar to FSK modulation except that the Gaussian filter is used to shape the pulses of logical Zeros and Ones before they are passed onto the FSK modulator.
- Here FSK generates two types of carrier waves and according to the input data one wave is given to the output for FSK modulation.

4.2.2.1 *Authentication*

There are many algorithms for this purpose and one of the common algorithms is, one node sends a challenge to the other node.

- The other node responds by sending back the same received challenge for authentication from the first node.
- In this process this process is used for the process of authentication.
- As the Bluetooth is implemented only as one to one communication there is no much complexity in implementing Bluetooth protocol as that of WLAN.

4.2.2.2 Hamming nodes

- The generator matrix of a hamming code of [n,k] is a kXn matrix and the. The generator matrix for the dual code is (n-k)Xk matrix.
- The check matrix is an nXk matrix.
- The K-bit message is multiplied by the generator matrix and on the receiving end the generated code word is again multiplied by the check matrix.
- The decimal equivalent of the obtained number tells us where the error has occurred.

5. RESULTS & DISCUSSION

The non-graphical results expected in this paper are summarized as follows.

- There are many coding techniques included in the model like convolutional codes, hamming codes etc.
- The algorithms designed for the various coding technologies are verified with given sample data and are found to be correct.
- All the verified algorithms are included in the Simulink model successfully.

The graphical results of the paper include the following aspects.

- There are two basic modulation schemes used in this paper. BPSK and PSK. These schemes were plotted for a given sample data and are included.
- The effect of noisy channel is also plotted and the recovered signal is also plotted.
- At last the BER curve for the Nakagami channel with the specifications mentioned above is plotted.
  The graphical results are included below.

5.1 Basic modulation schemes

The BPSK generated signals for a sample set of data at 1 MHz Frequency is as follows.

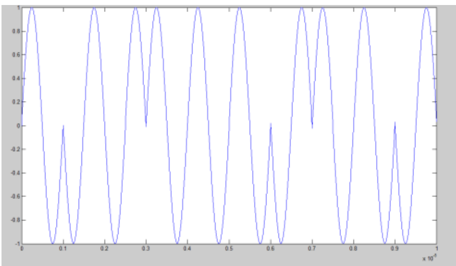

Fig 3 Modulation scheme 1

BPSK modulation for sample set of bits[1 0 0 1 1 1 0 1 1 0].The sample PSK at 1 MHz and 2MHz is given below.

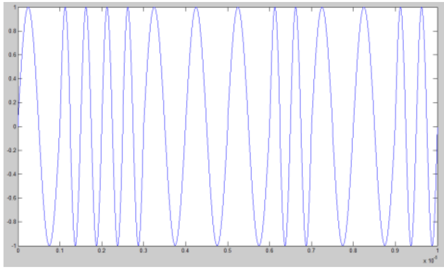

Fig 4 Modulation scheme 2

BPSK modulation for the sample set of bit [1 0 0 1 1 1 0 1 1 0].

5.2 Effect of noise on the BPSK modulation for different values of channel parameter m

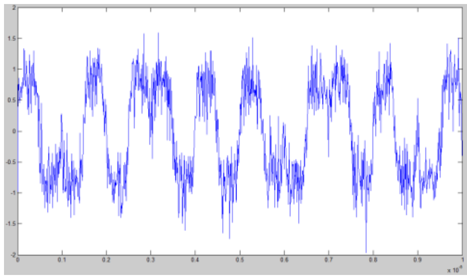

Fig 5 BPSK modulation With m=1

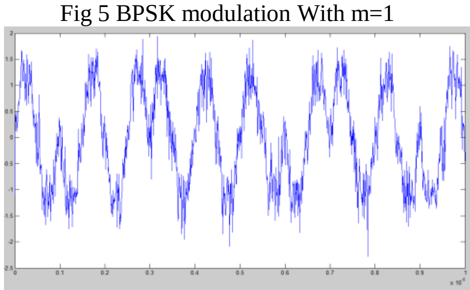

Fig 6 BPSK modulation with m=2

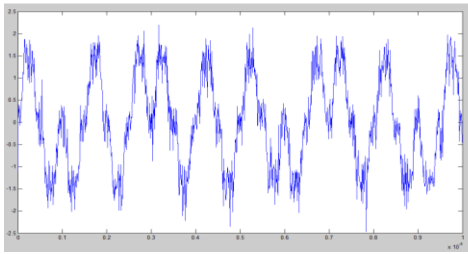

Fig 7 BPSK modulation with m=3

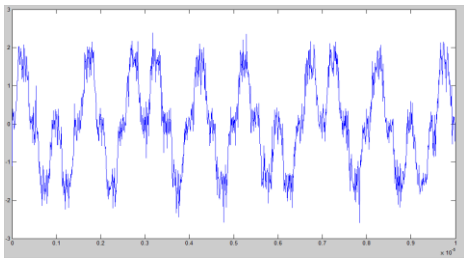

Fig 8 BPSK modulation with m=4

So from the above plots it is clear that as the value of m is increasing the noise level of the signal also decreases.
Now the smoothened signal for m=4 is shown below

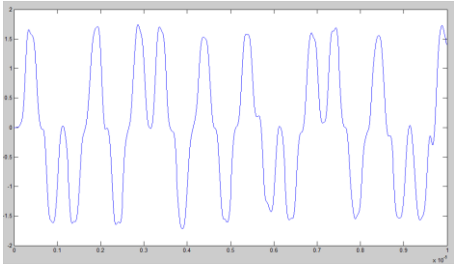

Fig 9 Smoothened signal for m=4

The following inferences can be made.

- Since the fading is flat as explained in the chapter II, the characteristics of the signal are preserved and are not distorted.
- This clearly implies that impulse of the signal does not change and the original message can be retrieved or the signal can be used for demodulation without any problem.
- Small adjustments for the timing synchronization can be made in the receiver.
- Since an SDR platform is used it is very easy achieve timing synchronization using various techniques.

5.3 BER curve on m-Nakagami channel

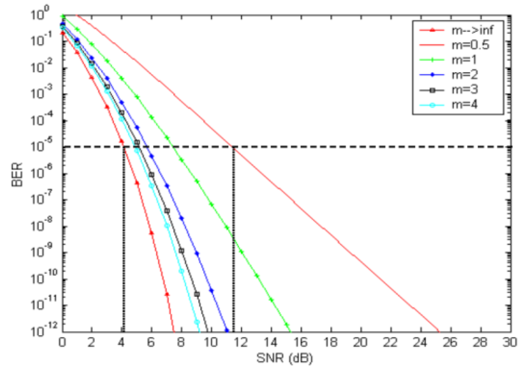

Fig 10 BER Curve for Nakagami-m Channel

The above graph is in accordance with the Nakagami-m Channel with the relation to the upper limit of probability of error derived in the section 2.6 of Second Chapter.

NOTE:

Some important aspects regarding the above reference curve are given below.

- The above curve holds good for a receiver employing Soft Decision Vitabri decoding algorithm.
- The above curve holds good BPSK and QPSK modulations with bit rates of 6 Mbps and 12 Mbps only.
- This curve is drawn by averaging of the upper limits of the probabilities of the errors for 48 sub-carriers of the OFDM wave. (Note: All the sub-carriers are treated independent waves and their individual BERs is measured. The BER for all the sub-carriers will not vary much and will be almost a constant).
- The curve changes if the modulation schemes are changed or higher bit rates other than the bit rates mentioned are utilized.

Inferences drawn from the above graph.

- For all the values of m = 1, 2 & 3. SNR the paper is modelled with an SNR of 10 dB and for m=4 the SNR is made to be 8.
- We can clearly note that more power is required to transmit the signals as fading condition (m parameter) increases in the channel

6. CONCLUTION

- Transceivers for the communication standard can be implemented in a pure software platform than the prevailing architectures.
- This implementation will narrow down the differences between the equipment currently in the present day market.
- Users will be greatly benefited from the equipment built using the SDR platform as they support multiple communication standards with the same given hardware.
- There will be no need of buying multiple equipments for multiple purposes as one equipment can take care of all the things.
- Active research is being carried out in this area and much commercial SDR equipment for different applications is available for commercial use. Presently their costs are very huge.
- In the near future all the mobiles, talkies that are used will become more and more flexible and tend towards SDR platform rather than the traditional architectures being used now.
- With the advancements made in VLSI and the microprocessors fields the architecture of an SDR becomes simplified rapidly.
- A day will come where a single transceiver can act as all in one and can be used as a mobile phone which can support both GSM and CDMA, which can also be connected to a WLAN access point, which has got Bluetooth connectivity, which can receive FM signals and work as FM radio etc.

7. ACKNOWLEDGMENT

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